

THE WATER AND SOIL EROSION AND THE CONTROL MEASURES IN CHINA

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Water and land resources provide the basis for the existence of human beings and the development of a nation. To well conduct water and soil conservation, control water and soil erosion and protect the eco-environment is a basic, long-term national policy of China in its striving for modernization.

1. General Situation of Water and Soil Erosion

1.1 Types and distribution of water and soil erosion

In China, the types of water and soil erosion mainly include hydraulic erosion, wind erosion, freeze-thaw erosion, landslide, mud rock flow and hill avalanche, in which hydraulic erosion and wind erosion are most common and distributed most widely.

The existing area of soil erosion of low degree and above in China is 3.67 million km², accounting for about 38.2% of the national territory, in which hydraulic erosion occupies 1.79 million km² and wind erosion 1.88 million km². Hydraulic erosion is the most principal type of soil erosion in China, mainly distributed in the vast areas south of the Great Wall and, in particular, is most serious in the middle reaches of the Yellow River and the upper reaches of the Yangtze River. In the Yangtze River Basin, soil erosion covers a total area of 562000 km² and the induced soil loss is 2.4 billion tons annually; and in the Yellow River Basin it covers a total area of 450000 km² and the induced soil loss is more than 2.2 billion tons annually. Wind erosion (also called desertification internationally) is mainly distributed in the areas north of the Great Wall and areas along the lower Yellow, and is particularly serious in Inner Mongolia, Ningxia and northern Xinjiang autonomous regions and Qinghai Province.. Lots of hill avalanche can be found in Guangdong, Hunan, Jiangxi and Fujian provinces and Guangxi Autonomous Region in South China; and lots of landslide and mud rock flow can be found in the upper reaches of the Yangtze River and the upper reaches of the Pearl River in Southwest China.

1.2 Serious soil erosion has caused heavy damages to the national economic and social development and already become the most important environmental problem in China

Serious soil erosion damages vegetation, causes land degradation, makes farmland unsuitable for cultivation, induces increasingly frequent flood, drought and sandstorm disasters, causes eco-environmental degradation in large areas of land and slows down the rate of economic development. Because it is distributed widely, causes heavy damages, is difficult to control and creates a vicious circle of poverty and ecological degradation, it has been generally recognized as the number one environmental problem affecting the sustainable social and economic development of China.

1.2.1 Soil erosion causes land degradation, intensify the expansion of the land with sand and rocks exposed, damages the eco-environment and worsens the conditions for existence, which has intensified the problems of large population and inadequate farmland and inadequate reserves land resources in China. In particular, the southwest

movement of desert and the soil loss from thin soil layers in the limestone regions in the south have made many areas unsuitable for the existence of human beings. In the upper reaches of the Yangtze River, which are characterized by high mountains and steep slopes, and meager land and rich water resource, soil erosion has continuously damaged the precious land and water resource, hence the conditions for agricultural production and even for existence have degraded gradually, the eco-environment has become unbalanced and the environmental capacity for population has declined year by year. In the limestone areas in Guizhou Province, for example, farmers in some villages had to move to other places because of loss of farmland.

1.2.2 Soil erosion causes loss of water, soil and fertility, hence lowering the productivity of land, increasing the occurrence of drought and water shortage and damaging the conditions for agricultural production. As a result, in the whole country, at least 5 billion tons of fertile soil is lost along with about 100 million tons of nitrogen, phosphorus and potassium. The annual loss of farmland is 1 million mu (15 mu equals 1 ha) on the average.

1.2.3 Large quantities of sediment are carried down and deposited to raise the beds of rivers, silt up reservoirs and lakes, reduce the flood carrying and storage capacity greatly and intensify flood and waterlogging disasters. By now the storage capacity of reservoirs and ponds occupied by sediment has amounted to more than 20 billion m^3 in the country, equivalent to the loss of 200 reservoirs each with 100 million m^3 of storage capacity, and the induced direct economic loss is 10 billion yuan RMB. Because of soil erosion, the Loess Plateau has become an area criss-crossed by gullies and ravines, with sparse vegetation and poor eco-environment. Large quantities of sediment from the Loess Plateau are flushed into the Yellow River and have ranked the river among those with the heaviest sediment load in the world. The sediment deposited in the channel of the lower Yellow River is about 400 million tons annually, thus making the Yellow River a famous “suspended river” in the world to seriously threaten the areas along the middle and lower reaches.

Serious floods occurring on the Yangtze, Nenjiang and Songhua rivers in 1998 were mainly caused by abnormal climate and concentrated precipitation, but to some extent it can also be attributed to soil erosion that has damaged the eco-environment and reduced the flood carrying and storage capacity of rivers, lakes and reservoirs. The total quantity of soil erosion in the upper reaches of the Yangtze River is 1.56 billion t annually and the sedimentation-induced loss of storage capacity of reservoirs in those areas has exceeded 10 billion m^3 . The riverbed of the middle Yangtze River between Chenglingji and Hankou has been raised by 0.42 m on the average in the last 20 years, or 2.1 cm per year. The four tributaries of Xiang, Zi, Yuan and Li generally have their beds raised by about 0.6 m. The Dongting Lake receives sediment of 120 million tons annually and the area and storage capacity of the lake have been reduced by 1600 km^2 and more than 10 billion m^3 , respectively, because of sedimentation and reclamation. In Hubei Province, the total area of lakes in the 1980s was 61% less than that in the 1950s.

1.2.4* Soil erosion damages railways, highways and navigation lines and communication facilities and thus hinders the development of transportation and communication.

Particularly in Southwest China landslide and mud rock flow have become the most critical factors to threaten the security of communication.

1.2.5* The main factors causing soil erosion

The occurrence and intensification of soil erosion are mainly attributed to the unfavorable changes of natural conditions, in particular drought and warming of climate. But irrational development and utilization of natural resources have accelerated the occurrence and development of soil erosion. According to the investigation to the Three Gorges Reservoir area, the quantity of soil erosion on slope farmland accounts for 60% of the total. The other factors include mining, construction of roads and factories, etc in which prevention of soil erosion is ignored, landscape and vegetation are damaged and debris is discarded willfully; and also include predatory utilization such as indiscriminate lumbering and grazing, inadequate attention to fostering forest resources, declining forest coverage, grassland degradation caused by overgrazing, etc.

2. Administration of Soil Erosion Control

In the last 50 years, in particular since the implementation of reform and opening-up to the world, the Chinese government has attached great importance to water and soil conservation and eco-environmental improvement and has gradually established relatively complete administrative system and legislation system for this purpose.

2.1*Administration system

During the 1950s a Water and Soil Conservation Committee was established under the State Council with the working office installed in the Ministry of Water Conservancy. The Department of Water and Soil Conservation was installed within the Ministry of Water Resource by the State Council in 1994. During the restructuring of the State Council in 1998, it was clarified that the Ministry of Water Resource is responsible for the administration of water and soil conservation and the coordination of comprehensive harnessing of water and land resources in the whole country. The Ministry of Water Resource as the supervisor of the sector has carefully carried out a lot of work in advocacy and education, planning and coordination, organization of implementation, monitoring and enforcement, research and extension, etc.

At the same time, special agencies for administration of water and soil conservation have been installed in all the seven major drainage basin commissions, all the provinces and all the key prefectures and counties for water and soil conservation to take charge of the coordination, engineering construction, prevention and protection and monitoring and supervision for the activities of water and soil conservation and eco-environmental improvement.

2.2*Legislation system

The Regulations for Water and Soil Conservation of P. R. China was issued in 1985, the Law for Water and Soil Conservation of P. R. China was issued in 1991 and the Rules for the Implementation of the Law for Water and Soil Conservation of P. R. China was issued in 1993. More than 20 provinces have issued detailed rules for the

implementation of the law for water and soil conservation and a series of supportive laws and regulations. Relatively standardized teams for the enforcement of the law have also been established in order to strictly enforce the law, strengthen supervision and promote the control of soil erosion by law.

3. Important Measures for Water and Soil Conservation and Eco-Environmental Improvement

3.1 Taking water and soil conservation as a long-term basic national policy

The State Council issued the Notice on Strengthening Water and Soil Conservation in 1993, in which it is clarified that water and soil conservation is the lifeblood for the development in mountainous areas, the basis of territory and river harnessing and the basis of the national economic and social development, thus a national policy that must be insisted on for a long term. The governments at lower levels have strengthened the administration of water and soil conservation, included water and soil conservation in the plans of economic and social development and implemented water and soil conservation as an important component of strategies for sustainable development.

3.2 Approval of implementing the National Plan of Eco-environmental Improvement

The State Council had approved to implement the National Outline Plan of Water and Soil Conservation in 1993 and the National Plan of Eco-environmental Improvement in 1998. The Ministry of Water Resource has formulated the National Plan of Water and Soil Conservation and Eco-environmental Improvement, in which the middle reaches of the Yellow River, the upper reaches of the Yangtze River, sandstorm areas and grassland areas are defined as the key areas for water and soil conservation and eco-environmental improvement of the country, and strategies are provided to take key river basins as the key components, counties as units and small river basins as sub-units, carry out unified planning of hills, water, forest and road, rationally integrate structural measures, biological measures and tillage measures for moisture and soil preservation so as to realize comprehensive harnessing and development. In the plan it is put forward that the undertakings of water and soil conservation and eco-environmental improvement should create initial effects in 15 years with the soil erosion in key river basins practically put under control, and create significant effects in 30 years with the soil erosion in most areas practically put under control; and the great objective of making all the territory eco-environmentally sound should be practically achieved by the mid-21st century.

3.3 Implementation of projects of water and soil conservation and eco-environmental improvement in the seven major drainage basins

Projects for soil erosion control were implemented first in the eight key areas of the Wuding River in Shaanxi Province, Sanchuan River in Shanxi Province, Dingxi County in Gansu Province, Xingguo County in Jiangxi Province, the Three Gorges Reservoir area, etc in 1983, and then key projects for water and soil conservation and environmental improvement have been generally carried out in all the seven major drainage basins including the Yellow, Yangtze, Song-Liao, Hai, Huai and Pearl river basins and the Taihu Lake basin. The projects had covered more than 800 counties in

26 provinces by 1998. Comprehensive harnessing has been carried out in more than 10000 small watersheds and over 3,000 among them has been completed.

3.4 ~~Establishment~~ Establishment of key counties for eco-environmental protection

Establishment of 120 key counties for eco-environmental protection was carried out in the four key areas of water and soil conservation of upper Yangtze, middle Yellow, sandstorm areas and grassland areas, in which funds and technologies were intensively provided so as to accelerate the harnessing of soil erosion and promote the economy of those counties to develop rapidly.

3.5 ~~Demonstrative~~ Demonstrative projects for water and soil conservation and eco-environmental improvement

The Ministry of Water Resource had started demonstrative projects for water and soil conservation and eco-environmental improvement in ten cities, 100 counties and 1000 small watersheds in 1998 and it is planned to establish a batch of demonstrative projects of high quality, high standards and good benefits in three to five years.

3.6 ~~Prevention and protection~~ Prevention and protection projects for water and soil conservation and eco-environment

The central government has defined the key prevention and protection areas, key monitoring and management areas and key harnessing areas for water and soil conservation in the country according to the Law for Water and Soil Conservation of P. R. China, and all the provincial governments have also defined the areas accordingly within their jurisdictions. With the definitions of those areas, the existing areas of forests and agricultural cultivation with potential of soil erosion belong to the key prevention and protection areas, the areas of concentrated construction projects such as mining and road construction causing serious soil erosion belong to the key monitoring and management areas, and the middle reaches of the Yellow River, the upper reaches of the Yangtze River, etc with serious soil erosion and great influence on the national economic and social development belong to the key harnessing areas for water and soil conservation. In this way the focuses of water and soil conservation and eco-environmental improvement are defined and corresponding control measures determined so that control measures can be adopted according to local conditions and enforcement of the law can be strengthened in order to alter the trend of worsening soil erosion.

4. Achievements and Problems of Water and Soil Conservation and Eco-Environmental Improvement

4.1 In China, soil erosion control is carried out mainly by rationally integrating the measures of structure construction, trees and grass planting and tillage to preserve moisture and soil. The structural measures mainly include terraced farmland, dammed land, farmland formed with hydraulic filling, mainstay engineering to harness gullies, on-slope water system engineering, rain collection engineering, water saving irrigation engineering, landslide control engineering, mud rock flow control engineering, etc; trees and grass planting measures mainly include water and soil conservation forest, economic forest, fuel forest, forage grass and slope protection

grass, etc; and tillage measures to preserve moisture and soil mainly include contour cultivation, belt type cultivation, furrow planting, etc. Comprehensive harnessing of soil erosion has been completed for a total area of 780,000 km² in the whole country, in which terraced farmland, dammed land and farmland transformed from sandy land occupy 11.87 million ha, planted water and soil conservation forest, economic forest and orchards 40 million ha, remaining planted grass occupies 4 million ha. In addition, hundreds of millions of water and soil preservation works have been built.

4.2 After practices of years, China has formulated and issued a relatively complete set of rational national technical standards for water and soil conservation and formed a system of water and soil technologies with Chinese characteristics. That is, take key river basins as the key components, counties as units and small watersheds as sub-units, carry out unified planning of hills, water, forest and road, rationally select structural measures, biological measures and tillage measures to preserve moisture and soil according to local conditions, pay the same attention to economic benefits, ecological benefits and social benefits. The practices have shown that the comprehensive control system, which is developed from practices, is a fundamental measure for the harnessing of soil erosion and improvement of eco-environment.

4.3 The engineering for water and soil conservation has played a significant role in improving the eco-environment, promoting the development of rural economy and harnessing the rivers.

- * The existing water and soil conservation works can check and store 1.5 billion tons of sediment annually and increase the storage capacity by 25 billion m³, thus constituting an important component of the undertakings to harness the rivers. The works in the middle and upper reaches of the Yellow River reduce the sediment flowing into the river by more than 300 million tons annually.
- * The undertakings of water and soil conservation have effectively protected the local water and land resources and promoted the coordinated development of population, resources, environment, economy and society. In the Three Gorges Reservoir area in the upper Yangtze River key prevention and protection area, for example, after comprehensive harnessing of seven years, the population carrying capacity has been increased by 6-23 persons per km². In Yulin Prefecture of Shaanxi Province, which is situated at the southern edge of Mawusu Desert, water and soil conservation has been implemented with wind prevention and sand fixing at the core, and comprehensive harnessing measures and development have been implemented. Farmland of 86,700 ha has been created with hydraulic filling and a lot of water resource projects have been constructed, thus fixing and semi-fixing 400,000 ha of floating sand out of the total of 573,000 ha and reversing the trend of desert encroachment. Not only have the local natural circumstances and living conditions been improved, but also the farmland, highways and railways have been protected.
- * The conditions for agricultural production have been improved so as to promote the development of regional economy. By taking comprehensive measures to harness soil erosion, the annual grain yield has been increased by 17 billion kg and more than 10 million people have got rid of poverty. For example, in the upper reaches of the Yangtze River, the harnessing undertakings have eliminated

poverty for more than 5 million farmers; in the key harnessing area in the upper reaches of the Yangtze River in Longnan area of Gansu Province, the coverage of poverty has been lowered from 66% to 24%; and in the key harnessing areas of Sichuan Province, the percentage of poor households has been lowered from 15% to 5%. According to the investigation of 2000 villages covered by soil erosion control projects in Hebei Province, the projects have played a significant role in eliminating poverty for 85% of the villages and making 10% of the villages reach the well-off level.

- * The eco-environment has been improved, the social progress has been promoted and the quality of the people's life has been enhanced. By conducting harnessing in key areas, the coverage of vegetation has been raised greatly, the varieties of plants have been increased, natural disasters have been reduced, and habitats for wild animals have also been restored. The improvement of existence environment and enhancement of life quality have also promoted cultural and ethical progress in villages.

4.4* Problems existing in soil erosion control of China

Because of technical and financial limitations, the tasks of soil erosion control in China are still very arduous.

- * The areas of soil erosion to be harnessed in China total more than 2 million km² and, because of difficult communications, undeveloped economy and the severity of erosion, the jobs of harnessing are very difficult.
- * As limited by the rate of economic development and the integrated national power, it is still difficult for China to greatly increase the investment in water and soil conservation and eco-environmental improvement, shortage of funds is still an important factor limiting the progress of water and soil conservation.
- * The technologies of water and soil conservation and soil erosion prevention are relatively backward, in particular, advanced, appropriate technologies such as remote sensing monitoring technologies, information management technologies, computer based planning and design technologies, new engineering machinery and materials, have not been extensively applied to water and soil conservation projects.
- * The technical quality of engineers and technicians for water and soil conservation need to be further enhanced. Technical training and knowledge learning and capacity building of management and construction agencies especially need to be strengthened.

5. Strategies for Water and Soil Conservation and Eco-Environmental Improvement

5.1* The objectives of water and soil conservation and eco-environmental improvement

The overall objective of eco-environmental improvement in China is to harness

600000 km² of soil erosion areas by year 2010 and harness additional 1 million km² by year 2030, and efforts will be made to practically harness all the areas of soil erosion that are suitable to harness in the country by the mid-21st century so as to preliminarily realize sound development of the eco-environment.

5.2 ~~Key~~ Key areas of water and soil conservation and eco-environmental improvement

It has been determined according to the severity of soil erosion to take the middle and upper reaches of the Yellow River, upper and middle reaches of the Yangtze River, sandstorm areas and grassland areas as the key areas for water and soil conservation and eco-environmental improvement in China.

5.3 ~~Strategic~~ Strategic measures for water and soil conservation and eco-environmental improvement

- * Intensify implementation of the policy of putting prevention first and taking comprehensive control measures, strengthen advocacy to promote the awareness of water and soil conservation, intensify the enforcement of the law for water and soil conservation and the monitoring and supervision, and practically restrict the occurrence of man-made soil erosion.
- * Intensify the water and soil conservation and eco-environmental improvement with the focus on the seven major drainage basins. Further revise the engineering plans of water and soil conservation of the seven drainage basins according to the requirements by the National Plan of Eco-environmental Improvement, clarifying the objectives and priorities, taking key river basins as the key components, counties as units and small watersheds as sub-units, and carrying out comprehensive harnessing and development. The objective for the near term is to harness 50,000 km² of soil erosion with comprehensive measures annually.
- * Implement the policy of returning farmland to forest land for steep slope land and accelerate the reform of slope farmland. Take the projects to transform the slope land into terraced land in the middle and upper reaches of the Yangtze and the middle and upper reaches of the Yellow as special ones to gradually return the farmland on slopes of more than 25 degrees to forest land and grassland on the basis of ensuring the basic farmlands.
- * Make efforts to introduce and extend the application of remote sensing technologies, computer technologies, modern planning and design technologies and decision management technologies, well carry out pilots or establishment of demonstrative areas for the harnessing of small watersheds of various kinds, summarize and extend the applied technologies of water and soil conservation such as those of comprehensive harnessing of watershed, use of machine to construct terraced land, use of bank between fields, cultivation of economic forest and fruit trees, rain collection, cistern based irrigated agriculture, water saving irrigation, etc in order to accelerate the progress of soil erosion control.
- * Establish step by step the national monitoring network and information management system for soil erosion, periodically carry out remote sensing monitoring of water and soil conservation to understand the trend of soil erosion

in the country and analyze the benefits of water and soil conservation projects, so as to provide a scientific basis for the macro decision making of the state and the soil control undertakings. In the near term, the second national remote sensing based general survey of soil erosion will be carried out and at the same time monitoring of water and soil conservation centered on the seven major drainage basins will be implemented.